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STUDY OF THE TRANSIT TIME SUN-EARTH OF GEOMAGNETIC DISTURBANCES

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STUDY OF THE SUN-EARTH TRANSIT TIME OF GEOMAGNETIC DISTURBANCES *

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ABSTRACT

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A relation is formulated, which links statistically the Sun-Earth transit time of disturbances responsible for geomagnetic storms with sudden commencements (SSC) with the radioelectric energy radiated by the associated type IV radiobursts. Some conclusions relative to influence of interplanetary conditions are derived therefrom.

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COVER-TO-COVER TRANSLATION

According to our present-day knowledge [1], we admit that the surest means to identify on the solar disk a flare responsible for a geomagnetic storm with a sudden commencement (SSC) is the type-IV radioelectric emission [2]: We have found indeed that 77% of the SSC are connected with chromospheric flares attended by type IV outbursts. The commencement of a geomagnetic storm, i. e. the arrival in the vicinity of the Earth of the leading edge of Sun-emitted disturbance presents in regard to the associated flare a variable lag Δt, of the order of 2 days, which probably depends simultaneously on the magnetodynamic characteristics of the disturbance and the conditions prevailing in the traversed interplanetary

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* Etude du temps de transit Soleil-Terre des perturbations géomagnétiques. (Note transmitted by M. André Danjon).

space [3, 4, 5]. We have studied the variations of Δt by utilizing experimental sources covering a three-year period (January 1958 to December 1960).

We endeavored first of all to ascertain whether there is a dependence between Δt and certain characteristic of the solar flare. A statistical study shows that the effect on Δt of the optical importance is weak: this is visible in Fig. 1 (where the mean Δt time lags corresponding to flares of increasing importance are plotted) and was already recorded [6].

A much clearer dependence is obtained if one characterizes the flare associated to the storm by the importance of the type-IV radiobursts that attend it. We have characterized this importance by the product of the density maximum of the flux emitted in the vicinity of 3 000 mc/s by the duration of the outburst: The product E characterizes approximately the emitted energy in the centimeter wave range. This energy has already revealed itself as being a significant sign for the characterization of the importance of a flare [7, 8].

The diagram of the mean values of log E and of Δt is plotted in Fig. 2 and shows that statistically there exists a law of linear dependence between these two quantities, whose expression (determined by the method of least squares) is written

$$\Delta t = 2.8 - 0.6 \log E \qquad (1)$$

Δt being measured in days and E — in $10^{-17}\, J \cdot m^{-2} \cdot cps^{-1}$.

This relation allows to make more precise the most probable time lag Δt which corresponds to a given flare of importance E.

The linear correlation factor between log E and Δt is 0.74. The characteristic -type spans, plotted in Fig. 2, increase for low-energy events and this probably reflects the fact that the influence of interplanetary conditions is more marked for these events.

It may be noted that the dispersion of lags corresponding to most important flares is only of the order of a few hours.

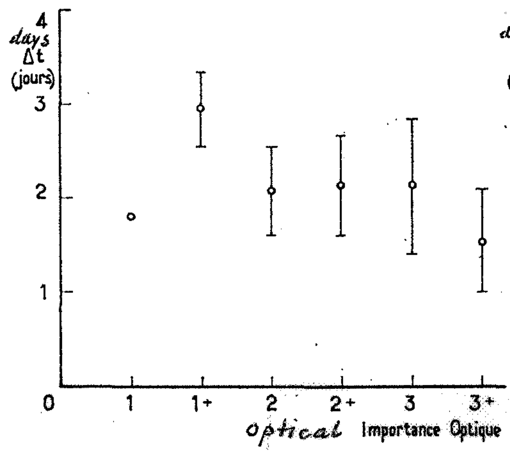

Fig. 1.

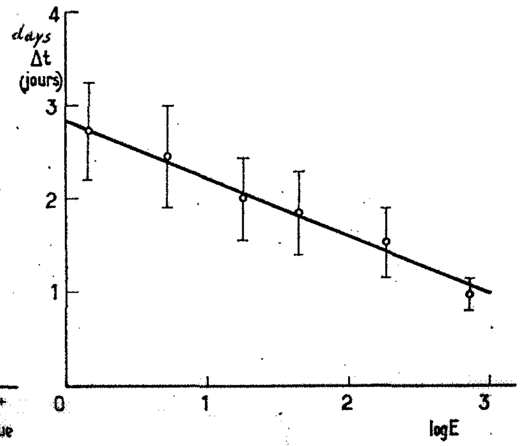

Fig. 2.

A certain aspect of the role of interplanetary conditions may be appreciated by considering the Δt corresponding to storms succeeding within a few-day lag a precedent storm. One may think indeed that the passage of the perturbation from the first storm modifies in a rather durable manner the interplanetary conditions, and it was already remarked that in fact the delays corresponding to second storms were statistically shorter [9].

However, as these second storms are often more intense than the first ones, we have reconsidered this phenomenon by correcting the effecr due to the importance of the type-IV burst, i.e. we rediced the observed lags to a common value of energy E with the help of formula (1). We shall limit ourselves here to describing the results of this study in which we have considered as second storm every storm occurring within 3 days after the first.

1. The lag Δt which corresponds to second storms is as an average by 8 hours inferior to mean lags corresponding to other stroms, This figure differs sensibly from the 21 hours reported elsewhere [9].

This succession effect exists as an average even for storms not originating in the same center of activity as the first storm.

2. For the second storms, the dispersion of all the values Δt observed diminishes sensibly after reduction by the formula (1): the typical lag passes from 8.3 to 4.8 hours upon reduction with a mean Δt of 44 hours.

Per contra, for other storms, i.e. the first storms and the isolated stroms, the dispersion is greater and it does not practically diminish, the typical lag passing from 12.8 to 12.4 h for a mean Δt of 52 hours.

The results just described reveal two important effects :

On one part they confirm that a disturbance which follows within a few days a first disturbance, traverses the interplanetary space under conditions such that it propagates in it more rapidly than the initial disturbance.

They show on the other hand that the propagation conditions encountered by the second disturbance are much more regular than those met with by the first disturbances and that these relatively steady conditions obviously subsist during several days.

*** THE END ***

Translated by ANDRE L. BRICHANT
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